

How to Make Extra Money **FIXING RADIOS**

NATIONAL RADIO INSTITUTE, WASHINGTON, D. C.

No. 8 **How To Test Tubes**
RADIO SERVICING METHODS



NRI TRAINING

Pays...

Dear Mr. Smith:

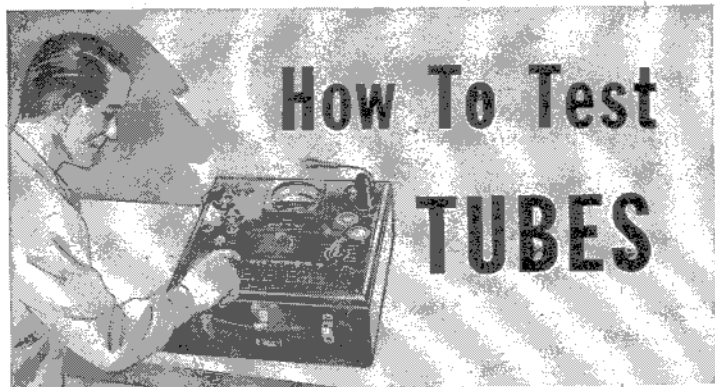
I have just completed the NRI Course and have a nice repair business established. I have been repairing radios since early in the Course, and did about \$400 worth of repair work while I studied. The Course easily paid for itself and purchased needed equipment. My only regret is that I did not study at NRI years sooner.

C.W.E., Ohio



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**NATIONAL RADIO INSTITUTE
WASHINGTON, D. C.**



How To Test TUBES

DESPITE constant improvements in their manufacture, tubes are still the weakest link in the radio chain. They may become defective in a variety of ways, and, since they are used in so many different sections of a radio receiver, they can cause almost any radio complaint. Defective tubes may cause a receiver to be dead, or weak, or noisy, or may cause distortion or hum—in fact, whatever complaint a receiver exhibits, a tube could be the cause of it.

You have already learned, in your Course in Radio Fundamentals, some of the ways in which tubes can become defective. Let's review the most common defects briefly, then learn how tubes are tested.

TUBE DEFECTS

The following paragraphs list the tube defects you will usually find in service work. We have listed these defects in their approximate order of occurrence. That is, those described first are found more frequently than those later, although this may not hold for certain specific tubes or receivers.

Open Filaments. All receiving tubes, with very few exceptions, contain wire filaments that are heated by the passage of a current through them. The heat produced is what causes emission of electrons, either from the filament itself or from a metallic cylinder (called the cathode) that surrounds the filament. A filament may break for any one of a number of reasons—from

mechanical shock, from fatigue caused by stretching and contraction each time the current through it is turned on or off, or from accidental application of too high a voltage. Whatever the cause, a broken filament cannot heat up and produce electron emission; the tube can no longer function. Usually this means the receiver will not operate, although occasionally the circuit arrangement may be such that the signal can pass around the tube and produce weak or distorted reception.

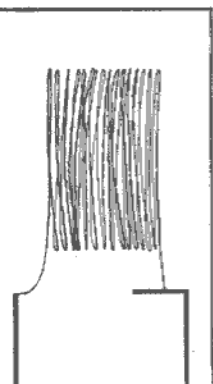
Leakages and Short Circuits. Often tube elements are spaced very close to one another, so it is possible for them to touch one another when the tube is subjected to vibration—caused by, say, the loudspeaker or by passing traffic.

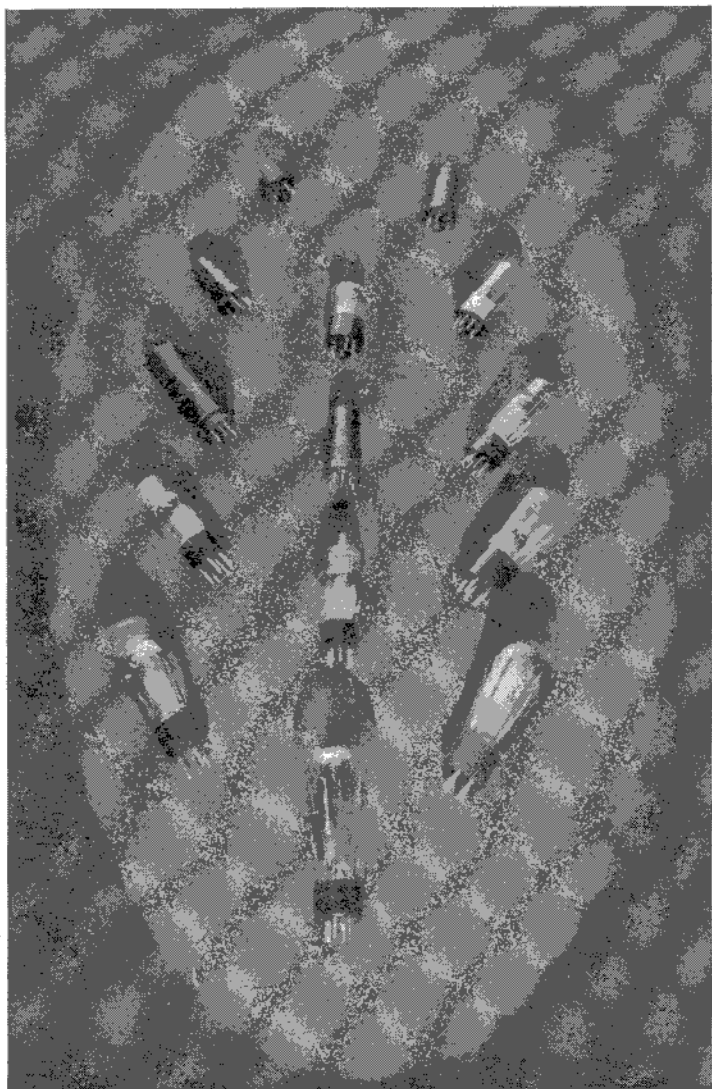
Leakage frequently develops between the filament and the cathode in an indirectly heated tube. In these tubes, the filament and the cathode are separated by a ceramic insulator which, with age, may become semi-conductive because of deterioration and deposits on its surface. Consequently, leakage often develops between the cathode and the filament.

The filaments of some tubes operate from higher voltages than do others, but draw the same amount of current. In other words, high-voltage filaments have higher resistance than low-voltage filaments. Usually, this high resistance is produced by making the filaments extra long and doubling them back and forth as shown in Fig. 1. With this construction, it is possible for one filament turn to short to another, so that the total resistance is reduced. This causes an extra current flow through the unshorted portion of the filament. This may cause the filament to burn out or may affect the life of another tube somewhere in the radio, particularly when other filaments are connected in series

Gas. Even after careful evacuation, there may be some gas left in the tube. Electron flow through the tube may ionize this gas, producing positive ions that will be at-

FIG. 1. High-voltage filaments are folded like this. If the ceramic coating (insulation) on the wire breaks down, the folds may short.





This photograph shows a collection of the radio tubes that have been, and are now, used in receiving sets. Notice that they vary considerably in size; in general, the most modern types are also the smallest. The large tube at the bottom of the center column is one of the early power rectifier tubes. More modern rectifier tubes are shown at the bottoms of the other columns. Bases with 4, 5, 6, 7, and 8 prongs are shown; most tubes now use the octal (8-prong) base. Metal tubes, and the small glass (GT) tubes, shown in the top half of the photograph, are very widely used in modern sets, where chassis space is usually at a premium.

tracted to the cathode or the filament and bombard it heavily. This will eventually destroy the emitting ability of the filament or cathode, and so ruin the tube. Gas within the tube can also cause a grid current flow, which, as we will see later in this Booklet, may cause distortion.

Loss of Emission. Even if nothing unusual happens to it, a tube will eventually "wear out"—that is, lose its ability to emit electrons. This does not happen abruptly; rather, the tube becomes weaker and weaker until finally the receiver goes dead. Tubes vary considerably in their length of life, depending chiefly upon their construction and the use to which they are put.

Loose Elements. Each element within a tube is welded to one or more supports, one of which acts as the connection to a prong in the tube base. A poor or erratic contact at the weld may result in an uneven flow of current through the tube, usually producing noise. Sometimes an element may break away from the support that acts as an electrical connection, producing what is called an "open" element. However, loose or open elements are rarely found today because of improvements in manufacturing.

Miscellaneous Defects. Tubes sometimes exhibit other defects, the reasons for which are more difficult to determine. For example, expansion of the elements caused by the heat of operation sometimes changes the tube characteristics. You can expect mysterious defects of this sort to appear occasionally.

► Now that we've reviewed tube defects, we shall go on to study how and when to test tubes. Some of these tests are made with a tube tester, others with an ohmmeter or voltmeter. To perform these latter tests, you must be able to tell which tube element is connected to each tube prong, so we shall take up the identification of tube prongs before going on to the tests.

HOW TO IDENTIFY TUBE PRONGS

Tube prongs may be readily identified from tube charts like those pictured in Fig. 2. You can get such charts from tube manufacturers or from the distributor



FIG. 2. Manufacturers list tube characteristics in manuals like these, which are free, or cost only a nominal sum.

or wholesaler from whom you buy the tubes; many are free; others cost ten to twenty-five cents. They are revised at least once each year, so get the latest copy when you need this information.

Fig. 3 shows how tubes are listed in a typical chart. As you can see, the tubes are listed by their type numbers, which are arranged numerically and alphabetically according to the RMA tube numbering code. That is, tubes are listed first by their initial numbers, which indicate the filament voltage classification: tube type 2B7 appears in the chart before type 6A3, because 2 is a lower number than 6. Tubes having the same initial number are listed by the letter or letters following the first number: the type 6A3 tube appears before type 6D7. Finally, tubes of the same initial number and same letters are listed by their last numbers, which indicate the number of elements within the tube that are brought out to base connecting prongs (or to a top cap): the 6A3 tube appears before a 6A4.

FIG. 3. A section from a typical tube hand-book.

Type	Construction			Emitter			Use
	Style	Class	Basing Diag.	Type	Volts	Amps	
6J8G	ST-12	Tri.-Heptode	8-H	Cathode	6.3	0.30	Mixer Oscillator
6K5G	ST-12	Triode	5-U	Cathode	6.3	0.30	Amplifier
6K5GT	GT						
6K6GT	GT	Pentode	7-S	Cathode	6.3	0.40	Power Amp.
6K7	Metal	Pentode	7-R	Cathode	6.3	0.30	Amplifier
6K7G	ST-12	Pentode	7-R	Cathode	6.3	0.30	Amplifier
6K7GT	GT	Pentode	7-R	Cathode	6.3	0.30	Amplifier
6K8	Metal	Tri.-Hexode	8-K	Cathode	6.3	0.30	Mixer Osc.

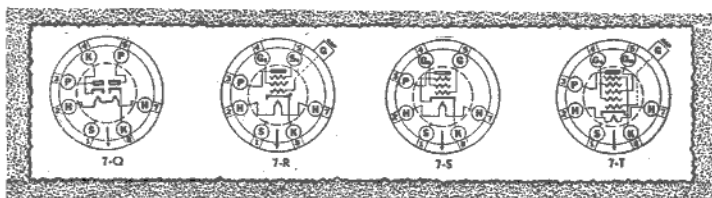
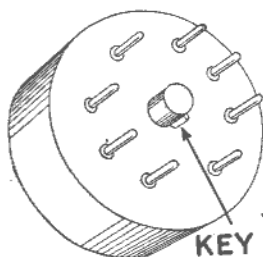


FIG. 4. One manufacturer represents the base layout of a tube like this. Others use different symbols.

This classification system makes it easier for you to find the tube you want in the tube chart. Once you have done so, follow its line across the page to the column marked "Basing Diag." or "Base Connections." Here you will find a key number, key letter, or group of numbers and letters; this designation identifies the base of the particular tube in a group of base layouts which you will find elsewhere in the tube chart.

Fig. 4 shows a typical base layout. Unless the chart states otherwise, the view shown is always the one you would see if you held the tube with the prongs facing you. This, of course, corresponds to an underside view of the tube socket. Since most of your testing will be made from the bottom of the socket, you will make use of a tube chart rather constantly in your service work.

► To take a concrete example, let us suppose we want to identify the prongs of the 6K7 tube. The chart in Fig. 3 indicates this tube has a type 7R base. Looking up the base in Fig. 4, we find it to be an octal type—that is, the base has provision for 8 prongs, which are numbered from 1 to 8; prong 1 is just at the left of the key on the tube base, and the others are numbered in order going clockwise around the circle of the prongs from prong 1. Fig. 5 is a closeup of an octal base, showing the location of the key.



Once prong 1 has been located, identification of the prongs is simple. The layout for the 6K7 tube shows prong 1 as a "blank," although the

FIG. 5. The locating key on an octal-base tube makes it impossible for you to put the tube in the socket wrong.

metal shell of a metal tube or a shield in a glass tube may go to this prong so that it may be grounded at the socket. (The shield connection may or may not be indicated on the base layout, depending on the tube chart you are using.) Prong 2 is connected to one end of the filament, prong 3 to the plate, prong 4 to the screen grid, prong 5 to the suppressor grid, prong 7 to the other end of the filament, and prong 8 to the cathode. Notice that there is no prong 6 on this tube. The control grid of the tube is brought out to the top cap, indicated by a small rectangle on the side of the base layout between prongs 5 and 7.

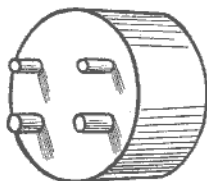
Most modern tubes use this octal base arrangement (or the loctal base, which is the same thing with a lock-in feature). However, other types of bases are also in fairly general use. Miniature tubes, used in very small portables and hearing aids, have 7-prong bases. And the older tubes, many of which are still in use, have 4-, 5-, 6-, and 7-prong bases. Fig. 6 shows typical examples of non-octal bases. However, regardless of the base arrangement, you can look up the tube in which you are interested and can then determine which prong connects to which element.

Now that you know how to identify tube prongs, let's see just when and how to test tubes.

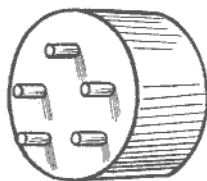
WHEN TO TEST TUBES

One thing you'll learn very quickly when you go into professional radio servicing is that the customer always expects you to check his tubes. Even if the defect has nothing to do with tubes, not one customer in a hundred will believe you have done a thorough repair job unless you check

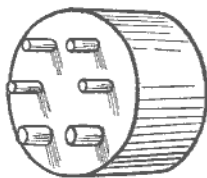
TYPES OF NON-OCTAL BASES



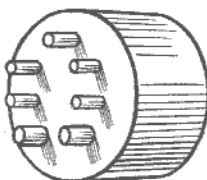
4 PRONG



5 PRONG



6 PRONG



7 PRONG



MINIATURE

FIG. 6

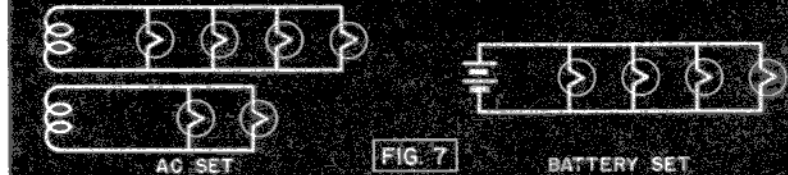
every tube when you repair the set — so, even if you know that the tubes are good, to please the customer, you must almost always check the tubes in a tube tester whenever you repair a set in his presence. Once you have shown him that the tubes are all right, he will be willing to consider other repairs.

However, although you will be practically forced to check all the tubes in each set you repair, this does not mean you should do so at the beginning of your service procedure. Remember—*your goal is to find the trouble as quickly as possible*. You'll develop a definite service procedure, as you go through your Course and these RSM Booklets, that will enable you to find the source of the trouble very quickly. In fact, you will usually be able to have a pretty good idea of just what is the matter before you test any tube, and, if a tube is to blame, you will probably have to test only one to locate the defect. You will very seldom find it necessary to check all the tubes in a set before you can restore it to operation. However, as we have said, you will have to check all the tubes at some time in the service procedure to satisfy the customer.

HOW TUBES ARE CHECKED

Most tube testing is done with a special piece of test equipment known as a tube tester. We shall describe the two main types of tube testers later in this RSM Booklet. However, tube testers are by no means infallible; in fact, it is often possible to make tests with an ohmmeter or voltmeter or by other means that will tell the condition of the tube more quickly than will a test with a tube tester. We shall describe these tests in detail before taking up tube testers. Some of the information we give you may be a little advanced for you right now, but you'll be able to put it to good use when you have gotten a little farther along in your study of servicing.

How To Check for Opens in Parallel Filaments. Tube filaments in most a.c.-operated receivers that use a power transformer, and in certain battery receivers, are connected in parallel in the manner shown in Fig. 7. If the filament opens in a tube so connected, that



tube will be dead, but the other tubes will not be affected. Some tubes have a visible glow when they are operating, and others, particularly metal tubes, become warm if they are operating properly. However, there are many glass tubes in which the filament cannot be seen, and many metal tubes do not become warm until they are run for some time. Thus, in many cases, you cannot rely on direct observation to lead you to the defective tube.

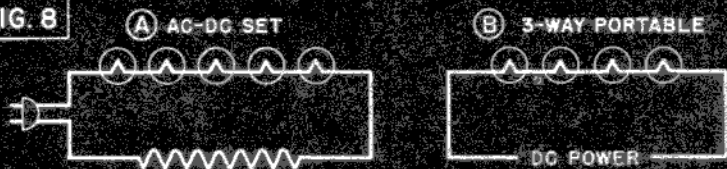
You can check any suspected tube readily for an open filament. Just remove the tube from its socket and check between the filament prongs with an ohmmeter; no reading indicates an open filament. If a replacement tube is handy, you can check the suspected one by plugging in the replacement and seeing if the radio operates properly.

When tubes are connected in parallel, it is very rare to find more than one tube with an open filament. If several tubes do not operate, the trouble is probably in the power supply circuit rather than in the tubes.

Opens in Series Filaments. In a.c.-d.c. sets, filaments are connected in series as shown in Fig. 8A. Some battery sets and three-way portables (a.c.-d.c.-battery-operated) also use series connections (Fig. 8B).

If one filament opens in a series filament arrangement, all the tubes stop operating. This is because the break in one filament opens the circuit and prevents current flow through any filament. The fact that a break exists in the filament circuit can be determined by checking between the prongs of the power cord (see Fig. 8A) with an ohmmeter. (The plug must NOT be in a wall socket, and the off-on switch must be turned on.) No reading indicates that a break exists

FIG. 8



somewhere in the circuit. However, to find the actual defective tube, it is necessary to pull all of them and check their filaments individually with an ohmmeter, or to check the tubes in a tube tester.

Tests for Gas. Few tube testers have an adequate test for gas. Of course, a gassy tube will eventually destroy itself, and the tube tester will then indicate that it is defective. However, a gassy tube may cause disturbances in circuit operation long before it destroys itself. Positive ions in a gassy tube draw electrons to the grid, thus producing a grid current flow through the external grid circuit. In some circuits, this grid current flow may produce a voltage drop in the grid circuit that will affect the operation of the tube.

Figs. 9 and 10 show two grid circuits. A gassy tube would cause little trouble in the circuit shown in Fig. 9, because the transformer T has such low resistance that any grid current flow produces too little voltage drop across it to be measurable. A gassy tube here would probably escape notice until the tube was ruined. How-

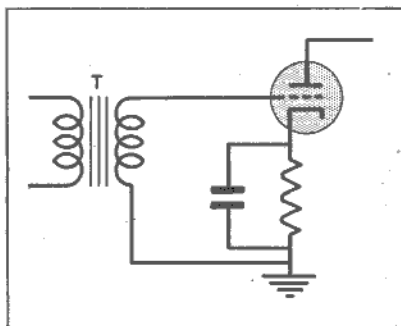


FIG. 9

ever, a gassy tube in the circuit in Fig. 10 would cause trouble. Here, R_2 is a rather high resistance, so even a small grid current flow through it would produce a voltage large enough to upset the bias. (The upset in the bias causes the radio signal to be distorted—the radio sounds as if it has a cold.) It is easy to check for gas in a tube in this circuit; all we need to do is measure the voltage across R_2 with a d.c. voltmeter with no signal tuned in. If we find a voltage across this resistance, then current is flowing through it.

Current flow through R_2 indicates one of two things: either the tube is gassy, or the coupling condenser C_1 is leaky. (If the condenser is leaky, electrons will flow from the B— terminal of the plate supply through R_2 , then through the leaky condenser and through R_1 back

to the B supply.) It is easy to distinguish between these possible causes if the set has its tube filaments in parallel, for then we need only pull out the tube and measure the voltage across R_2 . If the voltage disappears, the tube is gassy; if it remains, then the coupling condenser is leaky.

If the tube filaments are in series, as in an a.c.-d.c. and in some battery receivers, we cannot pull out a tube to make tests, because this interrupts the filament current for all tubes and prevents current flow through C_1 also. We must therefore make the test by disconnecting the condenser temporarily. If the voltage drop across R_2 disappears when the coupling condenser C_1 is unsoldered, then the coupling condenser is leaky; if it remains, the tube is gassy.

This measurement for voltage across the grid resistor is a standard test for gas. It is a typical example of why a professional serviceman is able to make a re-

pair faster than a "radio mechanic." The mechanic type of serviceman would have to make tests on the coupling condenser for leakage and the tube for gas, both of which are somewhat difficult. The professional serviceman, on the other hand, makes one simple voltage measurement and thereby finds that either the condenser or the tube is at fault and, with

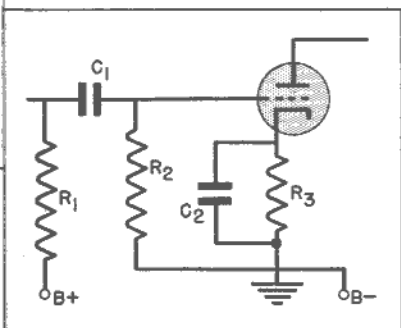


FIG. 10

another simple test, discovers which it is.

Tests for Loose Elements. We mentioned that loose elements will cause the receiver to operate erratically and noisily. An easy test for this is to thump or jar the tubes lightly one at a time with the receiver on. If the noise or erratic operation is increased when a particular tube is thumped, that tube probably has loose elements. Be careful not to jar the tube any harder than necessary, because the shock may go to some other part that is defective instead of the tube. When you believe

you have located the faulty tube, you can check it quickly by substituting another tube to see if the noise or erratic operation ceases.

Other Tests. Tests for other tube defects cannot be made readily within a receiver. To check the emission of a tube, or to find out if leakages, shorts, or open elements exist, it is best to check the tubes in a tube tester. Let's see what a typical tester is like and how to use it.

TYPES OF TUBE TESTERS

There are five requirements that a tube tester must meet to be useful to a serviceman:

1. It must give a satisfactory test.
2. It must be reasonably free from obsolescence—that is, it must not get out of date easily.
3. It must be easy to operate.
4. If the tester is a portable type, intended to be carried to the home of the customer, it must be light in weight and not bulky.
5. The tester must have “eye appeal”—it must impress the customer.

The last two of these are, of course, not technical requirements, but they are something to keep in mind when you buy a tester.

The other three requirements oppose each other to some extent. Obviously, the best way to test a tube is to apply normal operating voltages to it and measure its performance under the conditions to which it will be subjected in the radio. It is equally obvious that such a procedure is impractical in a tube tester that is designed to test all tubes. Tubes require widely different operating voltages, for example; this one factor alone would make it necessary for the tester to have a great many variable controls as well as an elaborate power pack. Such a tester would certainly not be easy to operate. Further, it would probably get out of date as soon as new tubes requiring different operating voltages or having different element arrangements were produced.

The easiest tester to operate would be one that had only one adjustment—say a dial that could be turned to a specific setting for each tube type being tested. It



These are two of the new sub-miniature tubes; they are shown actual size in this illustration. These tiny tubes are used in hearing aids and in "pocket" radio receivers. Some types have a basing arrangement instead of the wire leads, permitting the use of a tiny socket.

would be possible to make a tester of this sort that would give a satisfactory test. However, it would necessarily be so complex in its design that it would almost certainly go out of date as soon as new tubes were developed.

The result of these conflicting requirements has been a compromise. Modern tube testers give a reasonably satisfactory test, although by no means a complete one. They are relatively unlikely to get out of date, unless some radical new types of tubes are developed. And, finally, they are fairly easy to operate; it is necessary to adjust several controls or throw several switches to operate them, but it is a matter of only a few seconds to set them up to test a tube.

► There are two types of tube testers in general use today, the emission tester and the mutual conductance comparison tester. The emission tester is by far the more widely used. We shall describe both testers briefly, then describe the operation of a typical emission tester in some detail.

The mutual conductance of a tube is a measure of the control of the grid over the plate current. This tube characteristic is not measured directly by the mutual conductance comparison tester; instead, a measurement is made that shows roughly how the mutual conductance of the tube under test compares with the average mutual conductance of similar tubes. The meter of such a tester generally shows whether the tube is good, questionable, or bad.

When a tube is tested in an emission tester, all its grids are connected through the tester circuit to the

plate of the tube. A low voltage is then applied between the cathode and the combined elements (they act together as a plate, so the tube is effectively a diode), and the plate current produced is measured. The meter of the tester indicates whether the tube is good, questionable, or bad, and sometimes also gives a numerical indication of the amount of plate current.

Both testers give a fairly satisfactory test of the condition of the tube. At least, you can be sure that a tube is bad if the tester says so. That is, from the nature of the tests made, the tube will not always operate properly in a radio receiver if the tester says it is good, but it will always fail to operate properly if the tester says it is bad.

Both types of testers are relatively free from obsolescence. This is particularly true of those types of emission testers in which each tube element is brought out to a separate switch, thus allowing complete flexibility of connections. Generally speaking, either type needs only new calibration data to make it a suitable tester for new types of tubes. This will not hold, of course, if manufacturers bring out tubes that are greatly different from those the tester is designed to handle.

► In addition to their basic tests, both types of testers will show whether the tube has leakage or shorts between any of the elements. The test for leakages and shorts is always the first test made on the tube, since a tube exhibiting either of these defects can ruin the tester when a test for emission or mutual conductance is made.

Emission testers do not usually have any way of testing for gas in a tube, except that the presence of gas may cause an extraordinarily high emission that will move the meter pointer off-scale when the tube is tested. Some mutual conductance comparison testers do have gas tests, but this is by no means a universal feature of these testers.

Practically all tube testers are designed to operate from 115-volt, 60-cycle power lines. When operation on some frequency other than 60 cycles (25 cycles or 40 cycles, for example) is desired, most tube tester manu-

facturers, for a small increase in price, can supply a tester that will do this. In districts where only d.c. or storage batteries are available as power sources, a small inverter that will supply 115-volt, 60-cycle power from these sources may be used.

► Greater ease of operation, more freedom from obsolescence, and lower cost are the chief reasons why the emission tester is more popular than the mutual conductance comparison type. Now, let's see how you would use a typical emission tester.

A TYPICAL EMISSION TUBE TESTER

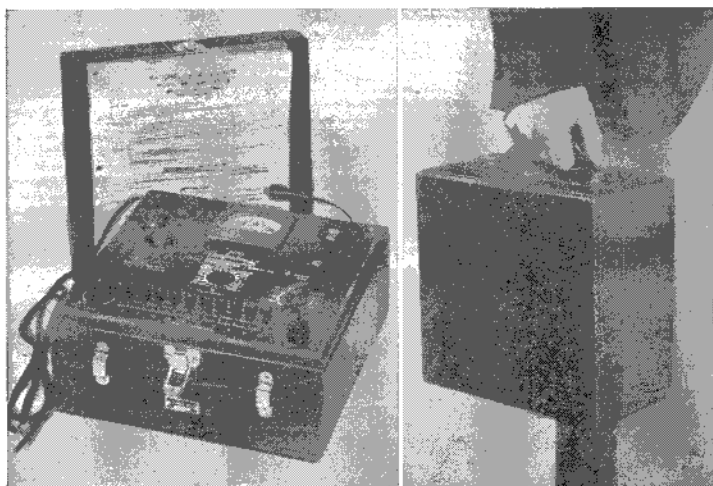
Fig. 11 shows a typical instrument that is designed to be carried out on jobs as well as to be used in the shop. When used in a shop, the lid can be removed and the tester set on the counter or in an instrument panel.

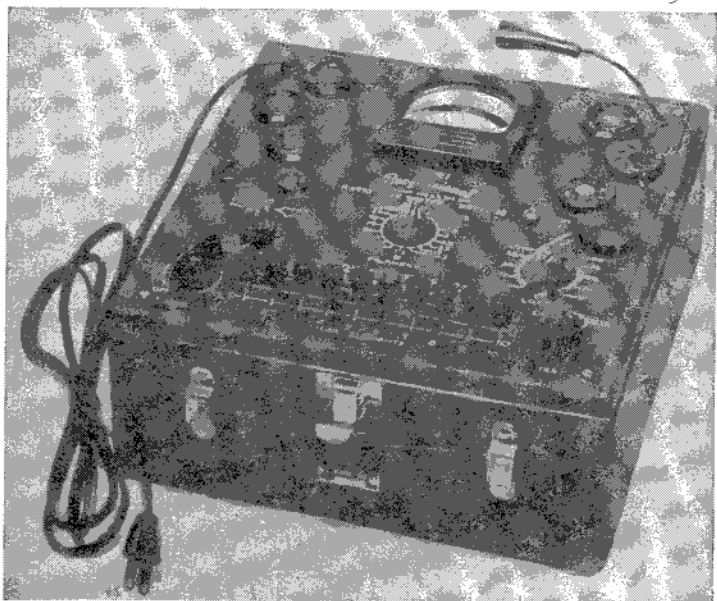
We're going to describe the procedure you should follow to test a tube in this tester. Although this exact procedure will apply only to the particular tester shown, any other emission tester can be used in much the same way.

Here's what you should do:

First, plug the power cord of the tester into an a.c.

FIG. 11. This is the Model 66 NRI Professional Radio Tube Tester, an emission tester with several exceptional features. As you can see, it is easily carried.





Close-up view of the NRI Professional Radio Tube Tester. The row of lever switches at the bottom of the instrument is used to connect individual tube elements to the testing circuit. These levers have a center position, and may be moved up or down, according to the instructions.

wall outlet. Then turn the *TEST* knob at the lower right to the "LINE" position and hold it there. The meter will indicate the line voltage. Turn the *LINE* knob at the lower left until the meter pointer is in the center of the scale at the position marked "LINE TEST." When you have made this adjustment, the tester has been calibrated for the line voltage and will now supply the proper voltages for tube tests. Release the *TEST* knob so that it may return to its center or "SHORT" position. (This knob is spring-controlled.)

► The first test you should make is for shorted elements. The tube should be tested for shorts while the filament is heated, since many shorts will occur only when the heat of normal operation has caused elements to expand. Therefore, before making any tests, you must apply the normal filament voltage to the tube.

The three center selector knobs are lettered *A*, *B*, and *C*. A tube tester of this sort is always accompanied

by a set of instructions that gives the settings for the *A*, *B*, and *C* knobs as well as the settings for the various levers (numbered 1 to 10). A section of the chart for this tester is shown in Fig. 12. Let us suppose, to take an example, that we are testing the 6K7 tube from these instructions.

Looking up this tube in a chart, we find that the *B* or filament knob should be set to 6.3 volts, which is the filament voltage for this tube. Therefore, after making certain that all the levers are in the center position, adjust knob *B* to this filament voltage and then plug the tube into the socket that it fits. The 6K7 tube has an octal base, so it fits the octal socket at the right.

The next step is to apply the filament voltage to the tube. At the right of the chart you will see a double column marked, "LEVER POSITION"; one of the columns is marked, *U*-Up; the other is marked, *D*-Down. The numbers shown in dark-face type in these columns indicate which lever switches should be thrown to apply voltage to the filament. Reading the chart for the settings for the 6K7 tube, you will find lever 2 in the "Up" column in dark-face type, and lever 7 in the "Down" column in dark-face type. Throw lever 2 to the "Up" position (marked *U* on the tester) and lever 7 to the "Down" position (marked *D* on the tester), and the proper filament voltage will be applied to the tube.

FIG. 12. This is a section of the instructions furnished with the NRI Professional Radio Tube Tester.

TUBE TYPE	KNOBS			LEVER POSITION	
	A Cir	B Fil	C Load	U Up	D Down
6K5	3	6.3	26	2	78
6K6	3	6.3	34	2	78
6K7	3	6.3	30	2	78
6K8	3	6.3	22	2	34678 10
6K8 Test 2.....	1	6.3	22	2	678
6L5	3	6.3	32	2	78
6L6	3	6.3	27	2	78
6L7	3	6.3	25	2	78
6N5	1	6.3	37	1	56

(Each of these lever switches is marked to correspond to the number of the tube prong to which it is connected. Thus, levers 1 through 8 correspond to prongs 1 through 8 of an octal-base tube; lever 9 is connected to a blank switch provided in case 9-prong tubes are introduced in the future, and lever 10 is connected to the flexible lead at the upper right that is used to make connections to the top caps of tubes having this feature.)

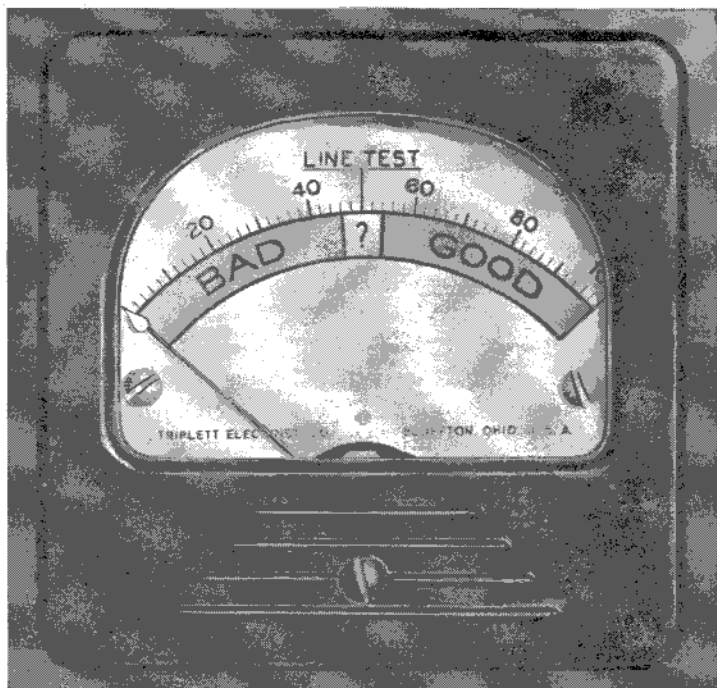
Next, connect the top cap clip to the top cap of the tube. The tube is now ready to be tested for shorts.

Move each lever (except 2 and 7, which you should leave in the positions to which you have thrown them) one at a time to the "Up" position *U* and back to the center. This connects each element in turn to a test circuit that will cause a neon lamp to glow if a short or considerable leakage exists between the element being tested and any other element in the tube.

A leakage or short exists between elements if the neon light glows: *A*, when *any* one lever other than a filament lever (lever 2 in this case) is in the "Up" position; or *B*, while *all* levers (except the filament levers) are in the center position. In either case, *make no further tests*; the tube is defective.

► However, when certain types of tubes are tested, it is not always true that a short or leakage exists if the neon tube glows. When a 6G7 tube is tested, for example, the neon lamp will glow when lever switch 3 is thrown to the "Up" position. This is supposed to happen and does not mean that the tube is defective; but, if the tube glows when any other lever is thrown, or when the levers are all in the center position, then a defect does exist in the tube. The tube tester chart will tell you when to expect short indications of this kind.

► After testing for shorts, you can check the condition of the tube. Since we are testing a 6K7 tube, set the knobs to the positions indicated in the "KNOBS" column for this tube. Thus, set knob *A* to position 3 and knob *C* to position 30; you do not need to move knob *B*, since it is already at the correct 6.3 setting. Set the levers to the position shown in the lever position column. This means you should set lever 8 to the "Down" (*D*) position;



The meters of most tube testers give both a Bad-?-Good reading and a numerical reading.

levers 2 and 7 should already be set to the proper position from the earlier tests. All other levers should be in the center position.

To make the test, hold the *TEST* knob at the lower right to the "VALUE" position and read the tube condition on the meter.

The meter scale is divided into colored segments. The segment at the left is colored red and marked **BAD**. The small center section is colored yellow and is marked with a question mark (?). The remainder of the scale is colored green and is marked **GOOD**. If the meter pointer deflects to any point within the green region, the tube is good. If it deflects to the questionable region, the tube is in doubtful condition, and, if not bad already, will probably be bad soon; it should be replaced if the customer is willing. If the meter pointer deflects to the red region, the tube is definitely bad. The sections of the meter dial are colored this way for two reasons—to

make it easier for you to check the tube, and to make it possible for the customer himself to see the condition of his tubes.

Numbers just above the colored sections of the meter scale are for making comparisons. In some receivers, it is necessary to use two tubes with matched emission in the output stage of the set. You can find such tubes by choosing a pair that cause a meter deflection to the same number in the *GOOD* region of the scale.

► The tests we have just described are all that are usually made for the 6K7 tube. Some tubes, however, like the 6K8, require two tests. These tests would be made in the same manner as those described. After completing your tests, let the *TEST* knob return to the center position and move all levers back to the center position. For safety, some servicemen always return the filament knob *B* to the "OFF" position in between tests of different tubes so that they will never accidentally apply a filament voltage higher than that for which the tube is designed. However, if you are testing a series of tubes that all require the same filament voltages, you may just as well leave the filament knob set to the correct voltage until you have finished that group of tubes.